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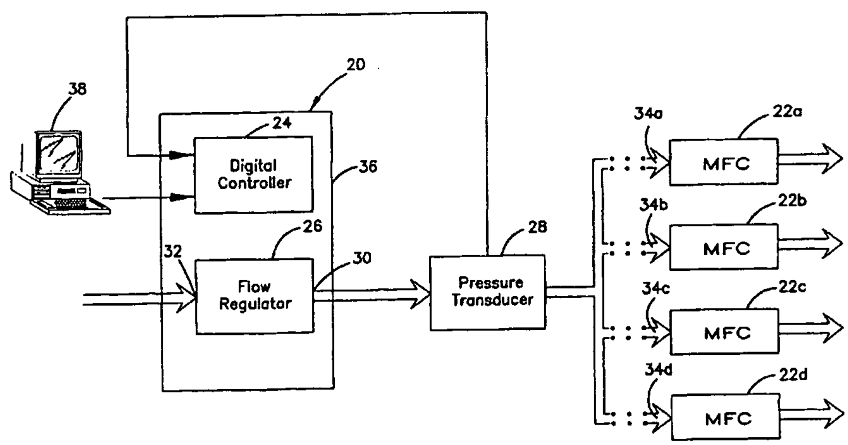
(54) Title: ELECTRONIC CONTROLLED PRESSURE REGULATOR SYSTEM



(57) Abstract: A miniature, compact, electronic controlled pressure regulator system (20) provides highly accurate pressure control in a fluid delivery system. The system is adapted for providing a constant pressure condition to a number of fluid lines (34a-d) which supply a fluid flow to a number of mass flow controllers (22a-d). The system is a closed loop electronic pressure control system. Pressure fluctuations caused by variations are continuously monitored and adjusted by a digital controller (24) such that a pressure regulator (26) adjusts its shut-off valve accordingly to maintain its outlet pressure. When used with a downstream orifice, the system holds a precise pressure to that orifice, thereby controling flow. Also, the system can be used to replace an MFC, eliminating the liquefied gas phase change problem.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

ELECTRONIC CONTROLLED PRESSURE REGULATOR SYSTEM

Field of the Invention

The present invention relates generally to pressure regulator systems, and more particularly, to electronic controlled pressure regulator systems for highly accurate control of pressure in fluid delivery systems.

Background of the Invention

In semiconductor and fiber optic fluid delivery systems, a mass flow controller (MFC) is used to control the delivery of semiconductor bulk and specialty gases. These systems include OEM (Original Equipment Manufacturer) fabrications, and semiconductor tool manufacturers.

In a typical gas delivery system, a number of MFCs are often used to control the gas delivery to the process chamber. Such a system includes a plurality of gas delivery lines. Pressure regulators are designed to control the pressures supplied to a number of MFCs. Generally, one pressure regulator is used to control the pressure supplied to a number of MFCs. A problem associated with this type of pressure control is that the process gases downstream from one MFC may at times shut off pressure or change pressure in that particular line. When that happens, pressure increases in the other lines and often causes the other MFCs flow to fluctuate and to shutdown.

The conventional solution used by the industry has been to install additional pressure regulators, one for each MFC process line. This is a very costly solution. It not only increases the manufacturing cost, but also requires more space for the additional regulators. Space is considered a precious commodity in semiconductor fabrication.

In addition, liquefied gases pose a special problem due to the fact that they often go through a phase change while flowing through small orificed devices such as MFCs. Inside an MFC is a bypass tube that a portion of the gas flows through. The temperature of the gas is measured as it flows through the bypass tube, thereby providing a measurement of flow. Commonly, liquefied gases flash back to a liquid state while traveling through the bypass tube, sending false readings to the controller of the MFC.

Further, the conventional pressure regulators used by the industry have been mechanical pressure regulators, for example, spring-loading pressure regulators, dome-loading, air actuated pressure regulators, or combination of spring-loading and dome-loading pressure regulators. The mechanical pressure regulators with a spring-loading mechanism are susceptible to the effects of shock, vibration and temperature. Further, the spring forces vary with compression and thus the load is not uniform. The mechanical pressure regulators with a dome-loading mechanism usually require two regulators, one is a dome regulator at the site, and the other one is a pilot regulator at the remote site. Further, the load pressure of a dome-loading pressure regulator can vary with sensor displacement. Furthermore, the greatest concern of the mechanical pressure regulators is the accuracy of the pressure control. The performance of a MFC is highly affected by the stability of the pressure supplied by the regulator. Due to the open loop characteristics, the mechanical pressure regulators generally fail to deliver a stable pressure to the MFC when flow requirements or conditions vary. This severely degrades the ability of the MFC to maintain a constant output or flow to a process line, e.g. a process chamber in semiconductor industry.

Also, typically, regulators are large in size. The regulators used in certain industries such as the semiconductor industry are required to be small and compact preventing adequate valve orifice to diaphragm ratios, which provides good mechanical regulator performance. In addition, due to the stringent requirements of today's semiconductor process tools, internal parts of regulators are required to be microscopically smooth and produce minimum in particle generation or entrapment, i.e. high purity, along the flow path.

Accordingly, there is a need for an improved pressure regulator system which provides highly accurate pressure control in a fluid delivery system that supplies a fluid flow to a number of MFCs. Also, there is a need for a miniature, compact pressure regulator system.

The present invention provides a solution to the above and other problems and offers advantages over the prior solutions to the above and other problems.

Summary of the Invention

The present invention provides an improved pressure regulator system, and more particularly, a miniature, compact, electronic controlled pressure regulator system. The pressure regulator of the present invention allows highly accurate pressure control in a fluid delivery system which supplies a fluid flow to a number of mass flow controllers (MFCs).

In general terms, the present invention provides a closed loop electronic pressure control system. Pressure fluctuations caused by variations are constantly monitored and adjusted. A digital controller may be used to maintain a constant pressure supply to the plurality of MFCs. Accordingly, the delivery system performance is enhanced and process variations are minimized.

The present invention provides a system which includes a shut-off pressure regulator having a digital controller to monitor and regulate pressure downstream continuously with precision regardless of changes in system conditions. The pressure regulator continuously adjusts or corrects its outlet pressure when the pressure and/or flow fluctuates, allowing the other MFCs to continue operation without incident. Accordingly, the present invention minimizes pressure cross-talk in multi-fluid line applications.

In one embodiment of the present invention, an electronic controlled regulator system is placed upstream of a plurality of MFCs. The system includes a pressure regulator, the pressure regulator having a fluid inlet, a fluid outlet, and a valve for controlling pressure of the fluid passing from the fluid inlet to the fluid outlet, the valve being opened/closed such that the pressure of a fluid flowing from the fluid inlet to the fluid outlet is continuously adjusted; a digital controller coupled to the pressure regulator, the digital controller controlling opening/closing of the valve; and a transducer coupled to the fluid outlet of the pressure regulator, the transducer continuously sensing pressure conditions at the fluid outlet and sending feedback signals to the digital controller such that the digital controller is capable of monitoring a deviation of the pressure conditions and adjusting the valve of the pressure regulator.

One advantage of the present invention is that when used with a downstream orifice, the present invention holds a precise pressure to that orifice, thereby

controlling flow. The present invention can also be used to replace the MFC, eliminating the liquefied gas phase change problem.

One aspect of one embodiment of the present invention is that settling time is reduced substantially. Settling time is the time required for the pressure to go back to the desired value after it has deviated. The cause of the deviation may be a change in one of the flow conditions or system conditions such as pressure or temperature. The cause of deviation may also be that the MFC shuts off its flow in its corresponding flow line. One advantage of the present invention is that it allows rapid response to flow condition fluctuation thereby reducing the settling time, increasing process throughput, and decreasing fluid usage.

Another aspect of one embodiment of the present invention is that the regulator includes a pneumatic mechanism, a valve and a diaphragm. The pneumatic mechanism provides a load to the regulator and adjusts opening/closing of the valve. The pneumatic mechanism is pre-set and adjusted by the digital controller. The valve is normally closed whereby the diaphragm is flattened. The valve is opened by the pneumatic mechanism whereby the diaphragm is flexed.

Another advantage of the present invention is that it significantly enhances performance of the MFCs by providing a highly accurate and constant pressure to downstream fluid lines.

A further aspect of the present invention is that the digital controller and the pressure regulator are enclosed in a miniature and compact housing. Accordingly, it significantly reduces the size of the regulator system. The compact regulator system can be a stand-alone unit which may be coupled to a plurality of fluid lines and pre-set by an external computer.

These and various other features as well as advantages which characterize the present invention will be apparent upon reading of the following detailed description and review of the associated drawings.

Brief Description of the Drawings

FIG. 1 is a block diagram of an electronic controlled pressure regulator system adapted to control a plurality of fluid lines connected to a plurality of mass flow controllers (MFCs) in accordance with the principles of the present invention.

FIG. 2 is a block diagram of a preferred embodiment of an electronic controlled pressure regulator system in accordance with the principles of the present invention.

FIG. 3 is an in-depth, partial cross-sectional view of an electronic controlled pressure regulator system in accordance with the principles of the present invention.

FIG. 4 is an enlarged, partial cross-sectional view of a pressure regulator of the electronic controlled pressure regulator system in a closed position.

FIG. 5 is an enlarged, partial cross-sectional view of the pressure regulator of the electronic controlled pressure regulator system in an open position.

FIG. 6 is a schematic diagram of outlet pressures under a different range of flow rates of the electronic controlled pressure regulator system in accordance with the present invention in comparison with the conventional pressure regulator systems.

Detailed Description

The present invention relates generally to an electronic controlled pressure regulator system, and more particularly, to electronic controlled pressure regulator systems for highly accurate control of pressure in fluid delivery systems.

In general terms, the present invention provides a closed loop electronic pressure control system. Pressure fluctuations caused by variations are constantly monitored and adjusted. An electronic controller may be used to maintain a constant pressure supply to a plurality of mass flow controllers (MFCs). Accordingly, the delivery system performance is enhanced and process variations are minimized.

The present invention provides a system which includes a shut-off pressure regulator having a digital controller to monitor and regulate pressure downstream continuously with precision regardless of changes in system conditions. The pressure regulator continuously adjusts or corrects its outlet pressure when the pressure fluctuates, allowing the other MFCs to continue operation without incident.

Accordingly, the present invention minimizes pressure cross-talk in multi-fluid line applications.

In the following description of the exemplary embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration embodiments in which the invention may be practiced. It is to be understood that other embodiments may be utilized as structural changes may be made without departing from the scope of the present invention.

FIG. 1 illustrates a block diagram of an electronic controlled pressure regulator system 20 which controls a pressure delivered from upstream to downstream fluid lines to a plurality of mass flow controllers (MFCs) 22a-d. It is appreciated that the number of MFCs can be varied. The pressure regulator system 20 includes a digital controller 24 and a pressure regulator 26. The digital controller 24 controls the pressure regulator 26. It is appreciated that other types of controllers, such as analog electrical controllers, may be used within the scope of the present invention.

In FIG. 1, a transducer 28 is coupled to the pressure regulator 26 to sense the fluid pressure at an outlet 30 of the regulator 26. The transducer 28 continuously sends the sensed fluid information back to the digital controller 24 such that the pressure regulator 26 continuously regulates the fluid pressure. The fluid flows into an inlet 32 of the regulator 26, out of the outlet 34, and to a plurality of fluid lines 34a-d. The fluid lines 34a-d supply the fluid to the MFCs 22a-d, respectively. The term "fluid" is preferably gas. It is appreciated that other forms of fluids, such as liquids, etc., can be used without departing from the scope of the present invention.

In FIG. 1, the digital controller 24 and the pressure regulator 26 are enclosed in a housing 36. The digital controller 24 and the pressure regulator 26 are designed and configured such that the housing 36 can be miniaturized to adapt for highly accurate pressure control in the semiconductor industry. In FIG. 1, the transducer 28 is not enclosed in the housing 36. It is appreciated that the transducer may be designed in the housing 36 within the scope of the present invention. // NB

Further, in FIG. 1, an external computer 38 may be coupled to the digital controller 24. The computer 38 can be used to upload the pre-set operation information, for example, the loading information for the pressure regulator. The

operation information can be determined by the flow requirements of each MFC, for example, a constant pressure at the outlet 30 of the pressure regulator 26. Also, the operational information can be downloaded from the digital controller 24 to the computer 38 or a display for monitoring, etc.

FIG. 2 illustrates a preferred embodiment of the electronic controlled pressure regulator system 20 in connection with the operation of the transducer 28 used in a gas delivery process. As stated above, the transducer 28 can be arranged as a part of the system 20. The system 20 includes a set point connector 40 to couple to the computer 38. The set point information can be digital signals. It is appreciated that analog set point information can be used within the scope of the present invention. Also, the feedback signals from the transducer 28 can be input into the system 20 via the connector 40. The details of the connector 40 will be discussed below. The system 20 also includes an actuation air input port 42 to provide a load to the pressure regulator 26. The air manifold is preferably arranged within the housing 36. It is appreciated that other types of arrangements can be used without departing from the scope of the present invention.

FIG. 3 is an in-depth, partial cross-sectional view of the electronic controlled pressure regulator system 20. The digital controller 24 includes electronic circuitry arranged on a printed circuit board (PCB) 44. The inputs of the electronic circuitry are coupled to the connector 40. The outputs of the electronic circuitry are coupled to a pneumatic mechanism 46 (FIG. 4) which controls the load of the pressure regulator 26. The pneumatic mechanism 46 receives air from the actuation air input 42 to provide the load for the pressure regulator 26. The amount of air, i.e. the amount of load, is controlled by the digital controller 24 preset by the computer 38 and is adjusted by the digital controller 24 based on the feedback signal from the transducer 28.

It is appreciated that the implementation of the electronic circuitry and the pneumatic mechanism 46 can be varied. One preferred implementation can be an electropneumatic PID Controller (PID stands for Proportional, Integral and Derivative), e.g. ER 3000 series of electronic pressure controllers, designed and manufactured by TESCOM Corporation, the assignee of the present patent application, residing at 12616 Industrial Boulevard, Elk River, Minnesota 55330.

The electropneumatic PID Controller may require 24 VDC with a maximum of 250 mAmps, up to 120 PSIG air supply and setpoint parameters, such as 1-5 volts, 4-20 mAmps. The microprocessor used to implement the PID control can be any suitable microprocessors, for example, the Motorola HC11 microprocessor. The setpoint parameters can be changed to accept digital setpoint parameters from a computer. The computer may monitor the system 20 and acquire data from the digital controller 24. In a preferred embodiment of the digital controller 24, the parameter for the power requirement of the system can be 22 to 28 VDC, 250 mAmps maximum; the parameter for the turn-on time of the system is smaller than 240 milliseconds, and the parameter for restart from power interruption of the system is smaller than 1.9 seconds. The input parameters for the setpoint connector 40 are preferably 4-20 mAmps, 1-5 VDC. The actuation input air for the pneumatic mechanism 46 is preferably inert gas or air with maximum pressure of 120 PSIG and minimum pressure of 80 PSIG. It is appreciated that other parameters can be used without departing from the principles of the present invention.

Further in FIG. 3, the pressure regulator 26 includes a sensor 48, preferably a diaphragm. The diaphragm is retained by side walls of the regulator 26 at its both ends. One function of the sensor is to sense changes in the downstream or outlet pressure side of a regulator. The diaphragm provides sensitivity to pressure changes. Where conventional elastomer types of diaphragms may not provide media or fluid compatibility, metal diaphragms are preferred, especially in the semiconductor, specialty gas and petroleum regulator industry. One type of metal diaphragm is made of 316 stainless steel. It is appreciated that other appropriate metal alloy materials, for example, Elgiloy®, a cobalt-chrome-nickel alloy, can be used within the scope of the present invention.

The pressure regulator 26 also includes a fluid orifice 49, a valve 50, and a valve seat 52. The fluid orifice 49 is normally closed by the valve 50 which is forced towards the valve seat 52 by the pneumatic mechanism 46. When the valve 50 is closed, a flow path 54 from the inlet 32 to the outlet 30 is shut off at the bottom side of the valve 50 as shown in FIG. 4. When the valve 50 is open, the valve 50 is pushed away from the valve seat 52 such that the orifice 49 is open for the flow path 54 as shown in FIG. 5. The flow path 54 flows from the bottom side of the valve 50

to the upper side of the valve 50. The fluid flows to the outlet 30. The diaphragm 48 is flat when the valve 50 is closed as shown in FIG. 4. The diaphragm 48 is flexed down when the valve 50 is opened as shown in FIG. 5.

The inlet 32 and outlet 30 of the pressure regulator 26 may be designed and arranged in a fluid pipe unit 56 separate from the housing 36 as shown in FIGs. 3-5. The fluid pipe unit 56 is mounted to the housing 36 by mounting means 58, for example, a pair of screws, etc. The advantage of having such arrangement is that the housing 36 can be used with different types or shapes of fluid pipe units. It is appreciated that the fluid pipe unit 56 can be integral to the housing 36 within the scope of the present invention.

Further, the internal fluid flow surface finish of the pressure regulator will be less than 10 RA (Roughness Average). It is appreciated that other appropriate specifications for the surface finish can be used within the scope of the present invention.

FIG. 6 illustrates a schematic diagram of the fluid outlet pressure (PSIG, Pounds Per Square Inch/Gauge) of the pressure regulator 26 of the present system 20 under a range of flow rates 0-70 Standard Liters Per Minute (SLPM) in comparison with the conventional pressure regulator systems. As the curves indicate, the regulator system in accordance of the present invention provides stable pressure control over the full range of its flow capacity. The preferred embodiment of the pressure regulator system 20 is capable of delivering point-of-use process gases at flow rates up to 70 SLPMs while maintaining a constant outlet pressure 30 PSIG. The pressure regulator system 20 in accordance with the present invention provides precise pressure control and eliminates the pressure loss (i.e. droop) that is found in conventional open loop point-of-use regulators. It is appreciated that the outlet pressure can be varied, for example, 0-70 PSIG, within the scope of the present invention. It is also appreciated that the flow rates can be varied depending on the appropriate ranges within the scope of the present invention.

Further, in the preferred embodiment of the pressure regulator system 20, the setpoint connector 40 includes nine electrical pins. The electrical pin assignments are preferably as shown in the following table:

PIN #	SIGNAL
1	Setpoint (1-5 VDC or 4-20 mA)
2	Signal Ground
3	Feedback (1-5 VDC or 4-20 mA)
4	RS-485 to PC (connection type to the computer)
5	Logic Ground
6	RS485 to PC
7	24 V Input
8	Power Ground
9	5V External (5mA Maximum)

It is appreciated that the electrical pin assignments can be varied according to the different applications of pressure regulators.

The electronic controlled pressure regulator system is often used in the semiconductor industry. It is appreciated that the system can be used in any other appropriate industries, for example, in the medical industry or the chemical industry, pharmaceutical industry, etc.

In operation, the computer 38 pre-sets a loading information for the pressure regulator and initiation information for the electronic circuitry of the digital controller. The pressure regulator is open to provide pressure to the downstream fluid lines and MFCs. The transducer senses the pressure or other fluid condition changes and feeds signals back to the digital controller. The digital controller then regulates the valve of the regulator via the pneumatic mechanism and the diaphragm. The valve is forced towards or away from the valve seat depending on the sensed signals. Such adjustment and monitoring is continuous. The settling time for the pressure or the other fluid conditions to go back to the desired value after it has deviated is substantially reduced. Accordingly, the system provides a highly accurate pressure to the MFCs.

Also, when the processed gases downstream from one of the MFCs is shut off or changed in a particular fluid line, the pressure changes in the other lines are immediately sensed by the transducer whereby the pressure regulator is adjusted

such that the pressure in the other fluid lines is essentially unaffected. Accordingly, the operation of the other MFCs can continue without incident.

Furthermore, in the preferred embodiment of the present invention, the pressure regulator system 20 is miniaturized. The preferred dimension of the system ranges from 4-5 inches in length, 1-2 inches in width, and 3.5-7 inches in height. It is appreciated that other dimensions can be used for the system without departing from the scope of the present invention.

It is to be understood that even though numerous characteristics and advantages of various embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of various embodiments of the invention, this disclosure is illustrative only, and changes may be made in detail, especially in matters of structure and arrangement of parts within the principles of the present invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed. For example, the particular elements may vary depending on the particular application for pressure regulator systems while maintaining substantially the same functionality without departing from the scope of the present invention.

Claims

What is claimed is:

1. A pressure regulator system coupled to a plurality of fluid lines downstream, comprising:

a pressure regulator; and

a digital controller controlling the pressure regulator to monitor and regulate pressure to the fluid lines downstream continuously with precision regardless of changes in the system, the pressure regulator continuously adjusting the pressure when conditions of one of the fluid lines change, allowing the other fluid lines to continue operation.

2. The system of claim 1, wherein the pressure regulator includes a fluid inlet, a fluid outlet, and a valve for controlling pressure passing from the fluid inlet to the fluid outlet, the valve being adjusted such that the pressure of a fluid flowing from the fluid inlet to the fluid outlet is continuously adjusted.

3. The system of claim 2, wherein the digital controller continuously controls adjusting of the valve.

4. The system of claim 3, further comprising a transducer coupled to the fluid outlet of the pressure regulator, the transducer continuously sensing the pressure conditions at the fluid outlet and sending feedback signals to the digital controller such that the digital controller is capable of monitoring a deviation of the pressure conditions and adjusting the valve of the pressure regulator.

5. The system of claim 4, wherein the digital controller and the pressure regulator are enclosed in a housing.

6. The system of claim 5, wherein the housing includes a port for connecting the digital controller to a computer.

7. An electronic closed loop pressure regulator system coupled to a plurality of fluid lines supplying a fluid pressure to a plurality of mass flow controllers (MFCs), respectively, the system comprising:

a pressure regulator having a fluid inlet and a fluid outlet; and

a digital controller coupled to the pressure regulator, the digital controller continuously monitoring pressure of a fluid flowing out of the fluid outlet, and continuously regulating pressure with precision regardless of a pressure change in one of the fluid lines;

wherein the pressure regulator adjusts pressure of the fluid flowing out of the fluid outlet, allowing the other MFCs to continue operation in a previous state regardless of the pressure change in one of the fluid lines.

8. The system of claim 7, wherein the pressure regulator further includes a valve for controlling the pressure of fluid flowing from the fluid inlet to the fluid outlet, the valve being adjusted such that the pressure of the fluid flowing from the fluid inlet to the fluid outlet is continuously adjusted.

9. The system of claim 8, wherein the digital controller continuously controls adjusting of the valve.

10. The system of claim 9, further comprising a transducer coupled to the fluid outlet of the pressure regulator, the transducer continuously sensing the pressure conditions at the fluid outlet and sending feedback signals to the digital controller such that the digital controller is capable of monitoring a deviation of conditions and adjusting the valve of the pressure regulator.

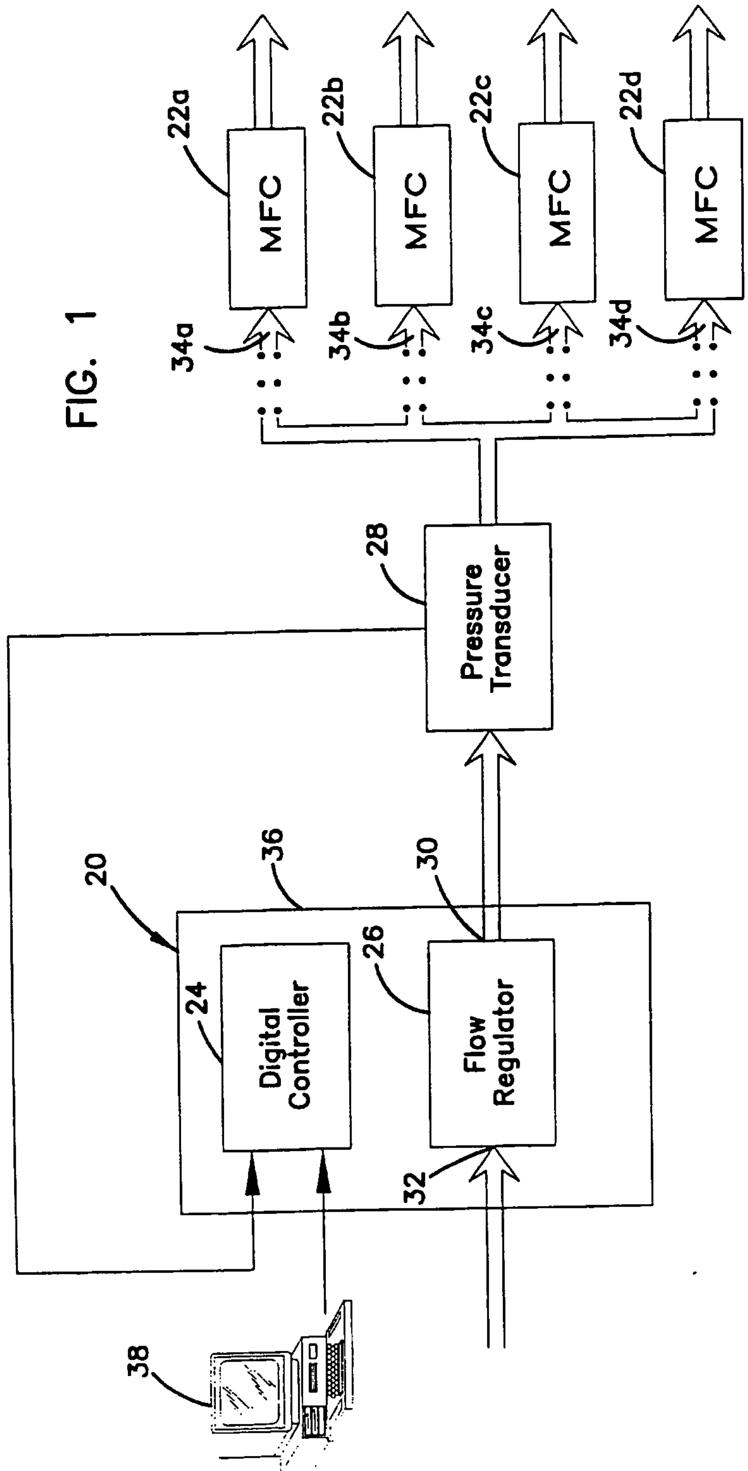
11. The system of claim 10, wherein the digital controller and the pressure regulator are enclosed in a housing.

12. The system of claim 11, wherein the housing includes a port for connecting the digital controller to a computer.

13. A pressure regulator system coupled to a fluid line downstream having a downstream orifice, comprising:

a pressure regulator; and

a digital controller controlling the pressure regulator to monitor and regulate pressure to the fluid line downstream continuously with precision regardless of changes in the system, the pressure regulator continuously adjusting the pressure when conditions of the fluid line change, holding a precise pressure to the downstream orifice, thereby controlling flow.


22a
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28
Pressure Transducer
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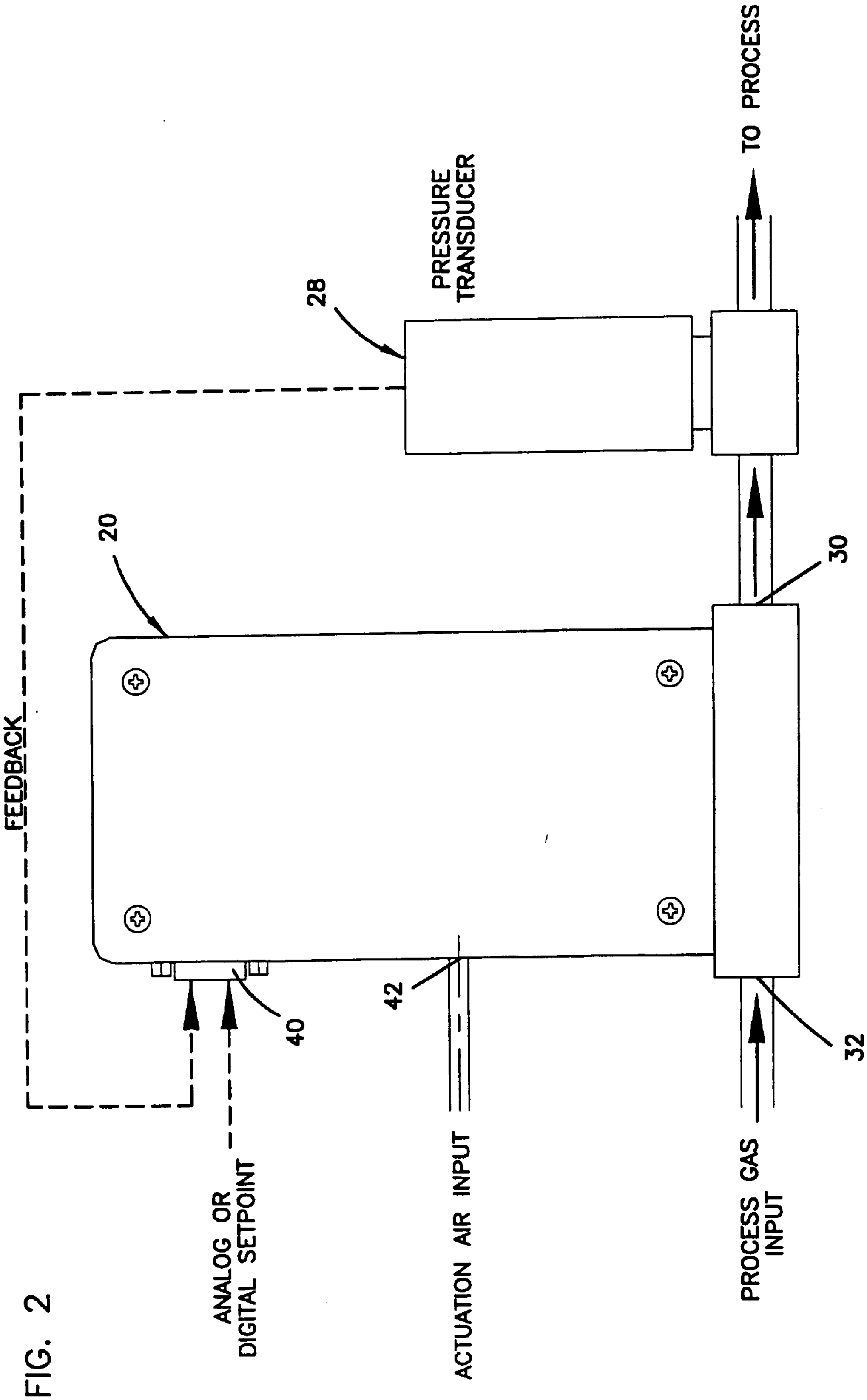
24
Digital Controller
Flow Regulator
32
38

FIG. 1


TO PROCESS
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TRANSDUCER
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ANALOG OR
DIGITAL SETPOINT
ACTUATION AIR INPUT
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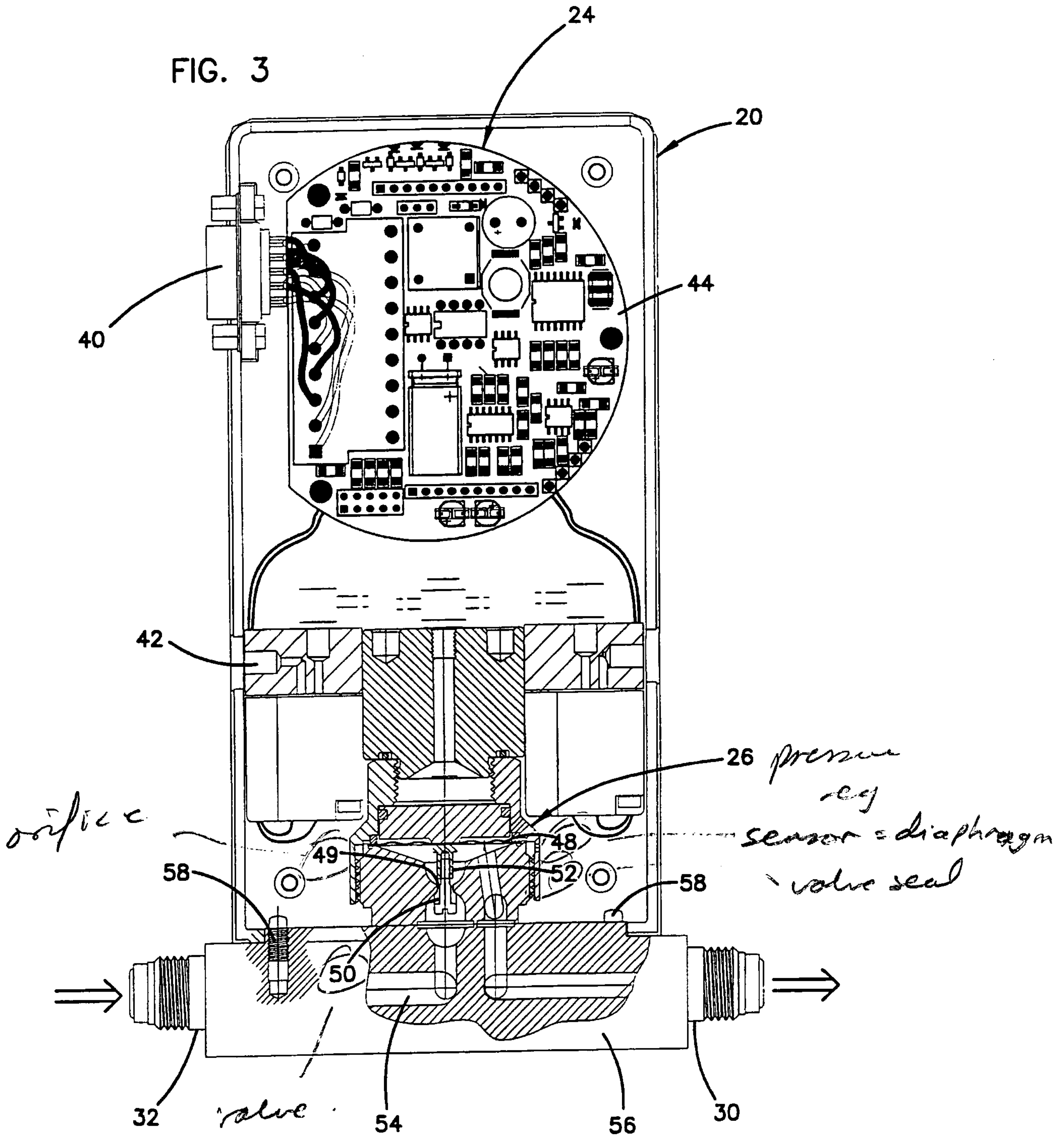
FIG. 2

FIG. 3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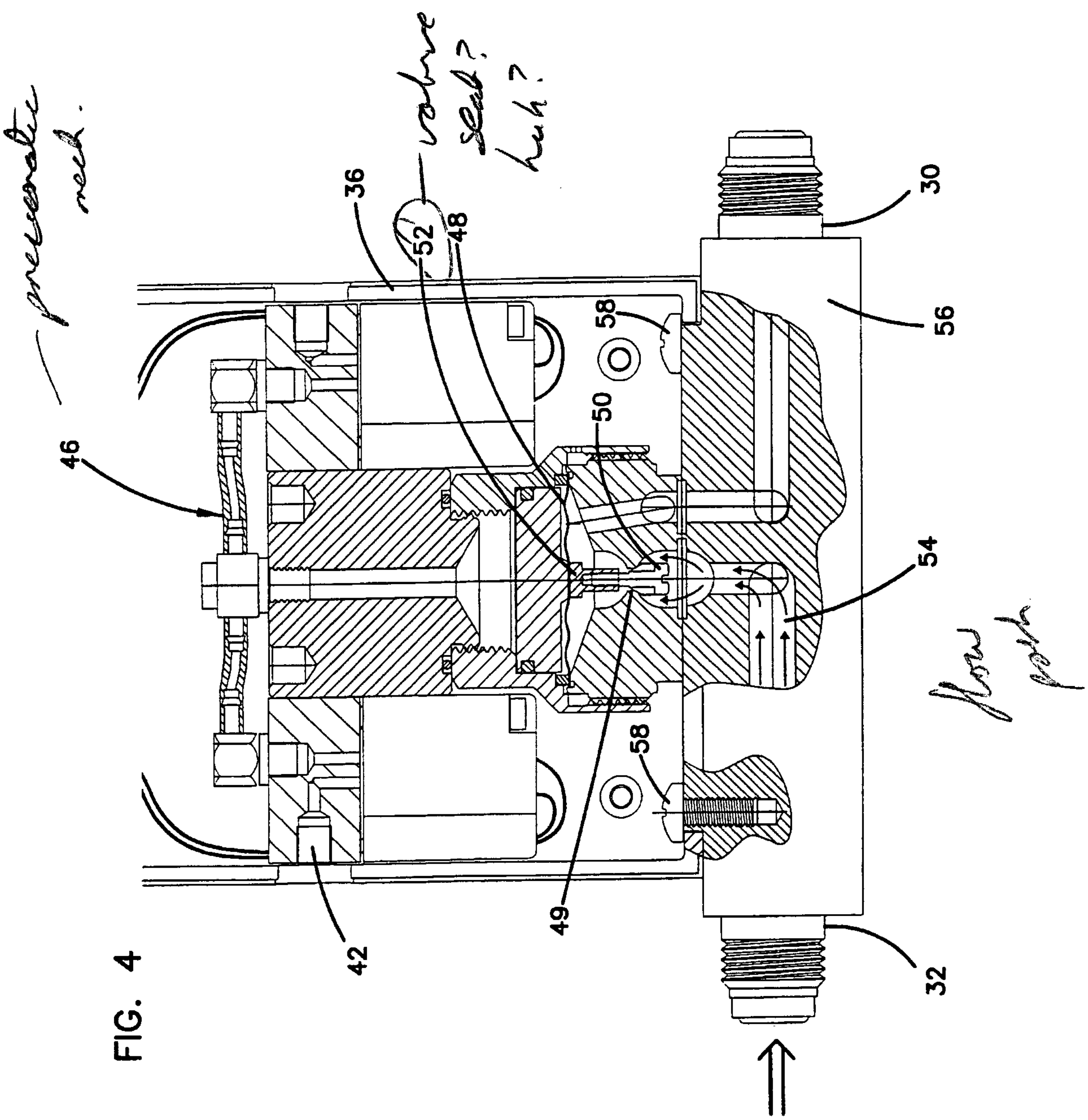


FIG. 4

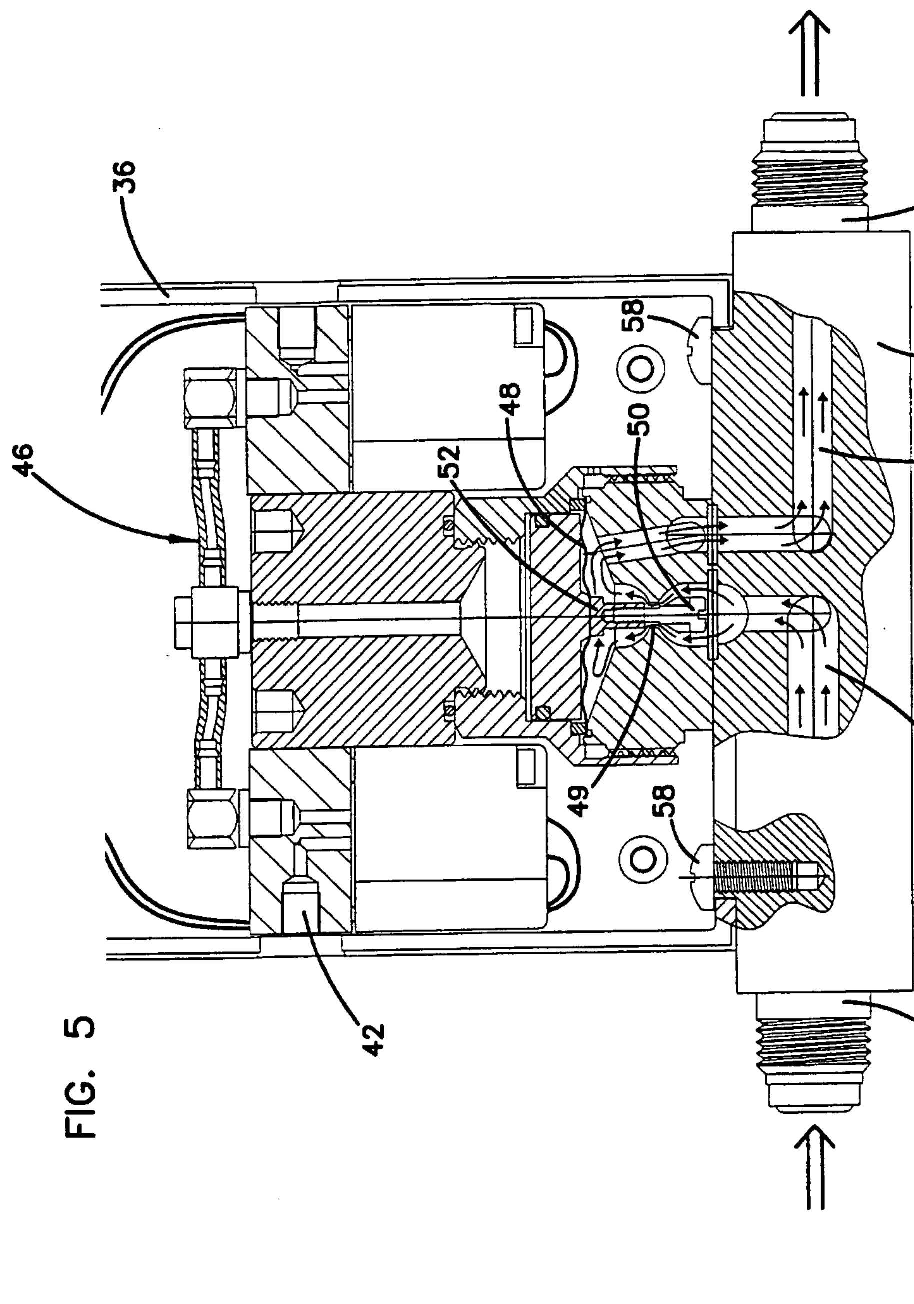
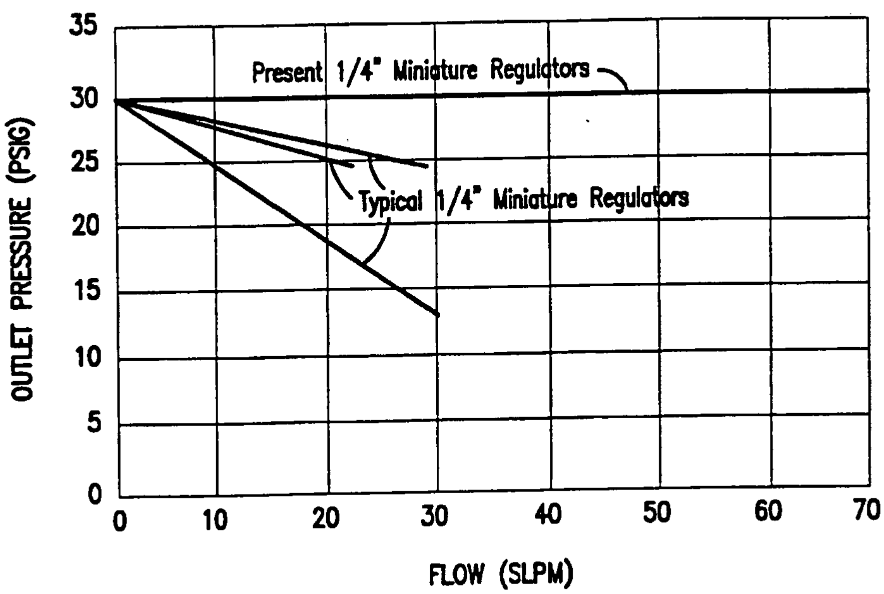


FIG. 5

FIG. 6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OUTLET PRESSURE (PSIG)
Present 1/4" Miniature Regulators
Typical 1/4" Miniature Regulators
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FLOW (SLPM)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/17939

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05D16/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 636 653 A (J.S. TITUS) 10 June 1997 (1997-06-10) column 2, line 37 - line 50 column 6, line 41 -column 7, line 7; figures 1-7	1-4, 7-10,13 11,12
X A	GB 2 316 773 A (GAS TECHNOLOGY CANADA) 4 March 1998 (1998-03-04) page 3, line 14 - line 18 page 6, line 5 - line 19; figure 1	1-4,13 7-10
X Y A	WO 99 15942 A (FISHER CONTROLS INTERNATIONAL) 1 April 1999 (1999-04-01) page 14, line 17 -page 17, line 20 page 26, line 17 - line 19; figures 3,4,6,7	1-4,13 5,6 6-12

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
19 October 2000	06/11/2000

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/17939

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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